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9.0 EFFECTS OF NURSE STAFFING ON HOSPITAL TRANSFER QUALITY MEASURES FOR NEW ADMISSIONS[1]

9.1 Introduction

The aim of this Congressionally mandated study is to answer the following question: Is there some ratio of nurses to residents below which nursing home residents are at substantially increased risk of quality problems?

This empirical question arises from the policy issue of whether minimum staffing standards should be required in nursing homes and if so, at what level. Thus, we are testing the hypothesis that identifiable thresholds exist below which quality of care is compromised. We do not need to demonstrate a linear relationship between staffing and quality of care, which clearly may not exist. Depending upon the nature of the relationship between staffing and quality, we may find multiple thresholds associated with incremental increases in quality rather than a single inflection point above which there is no added benefit of additional staffing. Our hypothesis is that staffing levels of RNs, LPNs, and nurse's aides will be associated with quality of care as measured by hospitalization for selected causes.

Hospitalization of nursing home patients is traumatic, costly, and can lead to hospital-acquired complications (Creditor, 1993). Quality of nursing home care is enhanced when health problems can be recognized early and/or treated in the nursing home setting without transfer to the hospital. If a facility has an abnormally high hospitalization rate, associated quality problems might relate to poor identification of declining health status, lack of sufficient skilled nursing care to treat the mix of patients admitted, and/or inability to provide special services, such as intravenous care, that might enable patients to be treated in the nursing home. Some estimates suggest that nearly half of all patients who are transferred to the acute hospital could be diagnosed and treated in the nursing home (Kayser-Jones, Wiener, & Barbaccia, 1989). Assessing hospitalization rates is particularly useful for examining staffing issues related to the short-term nursing home population because more than one-third of all transfers from nursing home to hospital occur within 22 days of nursing home admission.

A preliminary study on *Appropriateness of Minimum Nurse Staffing Ratios - Interim Report*

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conducted by HCFA (1996) found a relationship between staffing and rates of hospitalization for selected conditions. Poor quality was defined as being in the lowest 10% of the distribution on one of five quality indicators relating to the rate of hospitalization for respiratory infection, sepsis, urinary tract infection, diabetic crisis, and fractures among high-risk patients. Facilities in the lowest 5% of RN staffing were 3.4 times more likely to be in the lowest quality decile and facilities in the bottom 5%-10% were three times more likely to be in the lowest quality decile. However, the relationship was not linear. Patients were classified into high-risk and low-risk groups rather than adjusting for risk using regression models.

Another study of the relationship between staffing and hospitalization, conducted using both MDS and claims data, found no association between staffing and hospitalization at the patient level (Intrator, Castle, & Mor, 1999). In that study, researchers adjusted for both patient and facility characteristics but pooled all types of hospitalizations. Others have used hospitalization as a trigger for investigating quality of care. In a University of Colorado nursing home quality survey, hospitalization rates for new admissions were used to identify facilities with potentially poor care among a new admission sample. Medical records were then reviewed for these cases to determine whether quality problems led to the hospitalization. MEDSTAT developed hospital transfer quality indicators from Medicaid claims data and then conducted chart reviews to validate whether these indicators reflected care problems in nursing homes.

For hospitalization to be used as an indicator of quality, two critical issues need to be addressed. First, only potentially avoidable hospitalizations can reflect quality of care. Events such as stroke, myocardial infarction, elective surgeries, gastro-intestinal bleeding, and many other problems over which the nursing home has no control are not markers of nursing home quality. Second, risk adjustment is essential. Facilities that admit patients who are at greater risk for hospitalization are likely to have a higher hospitalization rate even when quality of care is high.

We analyzed hospitalizations for the following five diagnoses: congestive heart failure (CHF), electrolyte imbalance, respiratory infection, urinary tract infection (UTI), and sepsis. These were chosen because of their prevalence and the potential for avoiding hospitalization in these areas with appropriate care. One can hypothesize that improved nurse's aide staffing might avoid these problems (e.g., proper hydration may prevent electrolyte imbalance due to volume depletion), or lead to earlier recognition (e.g., peripheral edema as a sign of CHF), and thus reduce the need for hospitalization. Higher RN and LPN staffing might improve the supervision of nurse's aides, enhance problem recognition and evaluation, and increase treatment capability.

9.2 Methods

9.2.1 Design

The study is designed to examine associations between nursing home staffing levels, measured at the facility level, and quality measures that are aggregated from the patient level to the facility level. Thus, the unit of analysis is the facility, and quality measures represent facility rates. Recognizing that staffing probably does not have a linear relationship with quality, the design included use of continuous staffing and quality measures, and measures categorized into deciles and thresholds where staffing relationships might be most apparent. For each quality measure, we tested several thresholds in an attempt to identify the staffing ratio (or ratios) for each staff type that was most strongly associated with quality differences. We modeled the relationship between low staffing levels and quality using thresholds at the lowest 10%, 20%, and 30% of facilities and also used a recursive partitioning approach to find the staffing splits that explained the most variance in quality. We used multivariate methods to adjust for resident characteristics, but did not adjust for facility characteristics that were themselves strongly associated with staffing (e.g., for profit/non-profit, hospital-based/freestanding) because such adjustment would merely weaken the association between staffing and quality by using a proxy for staffing in the model. We did adjust for other facility characteristics (e.g., occupancy rate, urban/rural location, chain ownership).

9.2.2 Sample

We used a Medicare admission sample to evaluate hospitalization rates for selected conditions within 30 days of admission to the facility. The sample was drawn from claims data (Medicare Standard Analytic Files Part A) and included all Medicare stays regardless of whether the stay was the first admission to the facility for an individual or whether there were multiple admissions for the individual. This stay-level file was then aggregated to the facility level to assess hospitalization rates for selected conditions. The samples were drawn from New York, Ohio, and Texas for calendar years 1996 and 1997; the years were always analyzed separately. Facilities with fewer than 25 Medicare admissions over the calendar year were excluded from the sample for that calendar year because hospitalization rates for most conditions were unstable with denominators smaller than 25. The total number of facilities across the three states dropped from 2,557 to 2,398 (94%) in 1997 when we restricted the analyses to facilities with at least 25 Medicare admissions. The total number of facilities dropped to 1,786 when we matched the claims data to the Medicaid Cost Report data that provided the staffing information. Matched facilities were significantly more likely than unmatched facilities to be freestanding providers, have more beds, and have lower staffing levels, particularly for RNs.

9.2.3 Measures and Data

9.2.3.1 Quality Measures

The criteria used for selecting quality measures included the following:

1. The quality construct was likely to be affected by nurse staffing;
2. A sufficiently high incidence rate was found such that the measure was stable;

3. Identifiable risk factors were identified for which we could adjust;
4. We expected secondary data to be accurate based on available information.

We selected the set of hospital transfer quality measures included in this report by considering an array of potential hospital transfer indicators and narrowing the list based on these criteria. For example, we initially considered total hospitalization rates as a quality measure but were concerned that this construct might not be affected by nurse staffing because many hospitalizations are not potentially avoidable (Criterion 1). Furthermore, risk factors for hospitalization due to any cause are more difficult to identify than for disease-specific events (Criterion 3). We also considered hospitalization for fractures as a measure of falls in nursing homes, but the incidence rate for this measure was so low that the measure was not stable (Criterion 2). We also tried to find a measure that would capture adverse drug reactions (e.g., poisoning), but several sources suggested there was coding variation for this problem (Criterion 4).

The hospital transfer quality measures were obtained from the Medicare Standard Analytic Files Part A. The denominator for these facility-level variables was the number of Medicare admissions to the nursing home during the calendar year. The numerator represented the number of nursing home admissions who were admitted to the hospital within 30 days for a diagnosis that corresponded to one of the hospital transfer quality measures, including: CHF, electrolyte imbalance, respiratory infection, UTI, and sepsis. These diagnoses could be listed as either the primary or secondary diagnosis for the hospitalization.

Hospitalization for CHF includes heart failure regardless of the underlying cause, which is generally damage to the heart from prior heart attack or valvular heart disease. Congestive heart failure is a chronic illness that is the leading cause of hospital admission for elderly persons. The role of nursing home staff in treating CHF involves both preventive measures to avoid declining health and early identification of signs and symptoms of CHF that should be brought to the attention of a physician to avoid hospitalization. The prevention side consists largely of proper administration of medications, which would be the responsibility of an LPN or RN. Nurse's aides might help to avoid hospitalization for CHF by making certain that any fluid and dietary restrictions (e.g., low salt) are followed, and by early recognition of increased shortness of breath or increased edema. Nurse's aides and LPNs who see residents frequently could observe breathing difficulties and increased fluid accumulation. The most influential role of RNs might entail the supervision of the nurse's aides and the follow-up on their concerns about particular resident's conditions.

Electrolyte imbalance includes any disorders of the body's fluids or electrolytes (e.g., salt and potassium). Many of the hospitalizations for electrolyte imbalance result from dehydration (fluid depletion) or fluid overload in individuals with CHF. Less common medical conditions relating to kidney disease or acid-base status can also affect electrolyte imbalance. Nurse's aides play a major role in preventing hospitalization for electrolyte imbalance by proper hydration and assistance with

eating, while LPNs may play a role in proper medication administration and early recognition that an individual's physical and mental status is declining. RNs are essential for oversight and training of nurse's aides, as well as following up on any potential problems. Furthermore, treatment of electrolyte disorders in the nursing home may be possible through administration of IV fluids if sufficient licensed staff are available in the facility.

Respiratory infections include pneumonia that may be either bacterial or viral, and upper airway infections like bronchitis. While respiratory infection is an acute illness, it occurs with great frequency in individuals with chronic pulmonary disease. In frail, elderly persons who have difficulty swallowing, pneumonia often occurs as a result of aspiration in which food is regurgitated and brought into the lungs, particularly if the individual is not positioned properly. Thus, once again nurse's aides play a major role in helping to prevent aspiration pneumonia through proper positioning and feeding, preventing individuals with chronic pulmonary disease from getting cold, and reducing spread of contagious respiratory infections through proper infection precautions. LPNs and RNs play a valuable role, not only in supervising aides, but in assuring that all individuals receive both the pneumovax and influenza vaccination, and in enforcing appropriate precautions so that infections do not spread throughout the facility. In addition, early recognition of respiratory infection symptoms, contacting the physician, and initiation of antibiotics are critical to successful treatment of pneumonia.

Urinary tract infections (UTI) include infections of the bladder, kidney, prostate, urethra, or any other part of the urinary tract. These are bacterial infections, which often occur chronically in individuals at high risk, such as persons with urinary catheters or urinary obstruction. While bacteria in the urine may occur without an infection requiring treatment, any time there is an associated fever, discomfort, incontinence, or acute confusion, the UTI requires immediate treatment. Prevention of UTIs involves proper hydration and careful hygiene, including regular bathing, which are the responsibilities of the nurse's aide. Sterile procedures for urinary catheter care are essential responsibilities of LPNs and RNs. Early recognition of the signs and symptoms of UTI can avoid hospitalization by prompt physician contact and initiation of treatment. This requires attention from all staff and sufficient LPN and RN staff to supervise aides and promptly follow up on any atypical resident behavior (e.g., confusion) which might indicate an unrecognized UTI.

Sepsis includes infection of the bloodstream from any bacteria. The source of bloodstream infections is often a UTI, wound infection, or respiratory infection; however, any infection can result in sepsis if not promptly treated. Sepsis can be avoided if infections are identified and treated before bacteria become blood-borne, requiring nurse's aides to assist in preventing primary infections and to recognize any of the initial signs and symptoms of infection. RNs and LPNs must respond promptly when any symptoms of an infection are identified. This requires supervision of the nurse's aides, and attentiveness to the condition of the residents in the nursing home. Once sepsis occurs, the nursing home must hospitalize the patient for treatment, but the mortality rate even after hospitalization is extremely high.

Thus, all of these quality measures meet the first and most important criterion of a potential association with staffing. They all represent incident events in the nursing home of reasonably high prevalence (see Table 9.1). Claims data are a reasonably good information source because they are used for payment purposes and are audited. While there may be some ambiguities (e.g., CHF episodes coded as electrolyte imbalance), use of either the primary or secondary diagnosis helps to minimize the effects of coding practices with respect to the primary diagnosis. ICD-9-CM codes for these outcome measures are provided in Appendix F., Table 1.

9.2.3.2 Covariates

Ability to adjust for risk of the hospital event is a major concern, as previously discussed. We obtained case mix covariate data from the same Medicare Standard Analytic Files Part A using diagnostic information from institutional admissions occurring before the hospitalization. We chose the covariates based on clinical considerations and available literature and specified the appropriate ICD-9-CM code. If the diagnosis was listed for any stay in the prior six months (either nursing home or hospital) as either a primary or secondary diagnosis, the case mix covariate was denoted as present for the individual. The reason for using this relatively liberal criterion is that the covariates are all chronic conditions that would persist over time but are frequently under-reported during episodes with different primary diagnoses. As with the outcome measures, covariates were aggregated to the facility level. The denominator for these case mix measures was all admissions to the facility and the numerator was the number of admissions in which the resident were found to have the specific comorbid condition. We also had hoped to obtain covariates from MDS data by matching MDS forms with nursing home admissions. However, the advantage of this richer set of case mix characteristics was outweighed by the disadvantage of losing a large proportion of the sample because of problems encountered in matching the records. In total, only 34.3% of the residents' claims records could be matched to their MDS assessments.

For the comparison of staffing and quality measures, each covariate was relevant to only the hospital transfer quality measures for which there is a clinical relationship. Covariates for CHF acute hospital transfers included a chronic respiratory condition (chronic obstructive pulmonary disease, emphysema, asthma), diabetes mellitus, and a prior history of chronic CHF. For electrolyte imbalance, covariates included chronic CHF, chronic renal failure, and high blood pressure with renal failure or CHF. For respiratory infection, covariates included an underlying respiratory condition (e.g., chronic obstructive pulmonary disease, emphysema, asthma), and dysphagia - difficulty swallowing. For UTI, covariates included diabetes mellitus, quadriplegia or paraplegia, coma, and urinary retention. And for sepsis, covariates included conditions that decrease an individual's ability to fight infection, including diabetes mellitus, cancer, and HIV. The ICD-9-CM codes for the case mix covariates are included in Appendix F., Table 1.

9.2.3.3 Staffing Measures

We used four different staffing measures for these analyses: nurse's aide staff hours per resident day, LPN hours per resident day, RN hours per resident day, and the sum of RN and LPN hours per resident day. Types of staff were separated for these measures because from both a policy and clinical perspective, we need to be able to isolate the effects of different types of staff on quality. However, for many functions, there is widespread substitution between RN and LPN staff in nursing homes due to unavailability of RNs and to the numerous years of experience that some LPNs have in nursing home care. This is not to say that their qualifications are equivalent, only that they may function in similar roles in different nursing homes depending upon staff availability. Even if relationships between LPN staffing and quality or RN staffing and quality are not strong, it is possible that the sum of these two types of staff can be significantly associated with quality.

Staffing measure development, testing and editing procedures are described elsewhere (Chapter 8). We chose the most reliable staffing measure possible while preserving sample size to the greatest extent. Staffing data from the Medicaid cost report was used rather than OSCAR data because it was found to be more valid in a comparison with payroll data collected for a sample of facilities in Ohio. We did not include Director of Nursing (DON) time in these analyses. The correlation between Medicaid cost report data and payroll data was 0.73 for RN staffing, 0.64 for LPN staffing, and 0.39 for nurse's aide staffing. The Medicaid cost report data also tended to report higher RN, LPN and nurse's aide hours per resident day than payroll data in the 20% of facilities with the lowest staffing levels. Thus, nurse's aide staffing data are less accurate than data for RNs and LPNs, and staffing for the lowest-staffed facilities is probably overstated in these analyses.

We eliminated extreme outliers (total hours per resident day < .5 or > 12) which comprised only 1% of the samples of facilities with Medicaid staffing data. We did not exclude facilities on any other basis, such as consistency of staffing information over time, because such changes can represent actual staffing changes in a facility that occur because of changes in ownership, administration, case mix, and staff availability. While further decision rules were considered for editing Medicaid data, validation of these rules could only be based on OSCAR data that was shown to be a less reliable source of staffing data. Thus, we applied the outlier edits but chose to preserve sample size rather than applying any additional edits to the Medicaid staffing data.

9.2.3.4 Facility Characteristics

The risk of masking an association between staffing and quality is substantial if facility characteristics are co-linear with staffing. Thus, facility characteristics were selected based on hypothesized associations with quality, and only after examining correlations between facility covariates and staffing measures. Those factors strongly associated with staffing were problematic to include. The three facility covariates that we included were: urban/rural location, multi-facility organization, and occupancy rates.

We did not include ownership or hospital-based/freestanding because these characteristics were highly correlated with staffing levels. For example, the correlation between for-profit and nurse's aide hours was -0.26 ($p < .0001$). The correlation between hospital-based and RN hours was 0.25 ($p < .0001$). In some states, these correlations were even higher. We considered the use of one additional variable relating to physician FTEs for medical directors, but found such a large portion of missing data and responses of "0 FTE" that we could not use this variable.

The source of data for facility characteristics was the OSCAR data set. The definitions of the three variables that we used are provided below.

- A multi-facility organization (or chain) indicated a facility that was owned by an organization that owned at least one other nursing home.
- Urban vs. rural indicated whether the city in which the facility was located had a population above vs. below 50,000 residents.
- Occupancy rate was computed from the number of beds in the facility and the census at the time of the OSCAR visit.

9.2.4 Analysis

9.2.4.1 Descriptive Analyses

We determined the mean, median, range, and interquartile range for all of the study variables including quality measures, covariates, and staffing measures by year and by state. We conducted similar analyses on the pooled data across states for each year. We examined correlations among the variables including staffing levels and quality measures, covariates and quality measures, facility variables and staffing levels, and facility variables and quality measures.

A second type of descriptive analysis involved classifying facilities into staffing deciles and displaying quality of care and case mix deciles for the different staffing deciles. We chose deciles as a starting unit to assure that we had a sufficient sample size in each category for quality of care comparisons. The purpose of this descriptive analysis was to identify whether specific staffing thresholds were apparent below which quality measure values were lower in comparison to those above the threshold. However, the limitation of this descriptive analysis was that without risk adjustment, higher rates on the hospital transfer quality indicators could as easily reflect case mix as staffing.

A third type of descriptive analysis that we conducted involved using PC-Group (1992), a recursive partitioning program. PC-Group divides the sample into a specified number of groups such that facilities within each group are as similar as possible on a given measure and facilities in different groups are as different as possible on the measure. The algorithm identified the optimal level of staffing to divide the facilities into groups with better or worse quality. The limitation of this descriptive approach was that without risk adjustment, differences in quality measures could reflect case mix rather than

staffing levels that were used to define the splits. The advantage of this approach is that it was not restricted to deciles or other relative categories and more than one threshold was possible. In some cases, PC-Group could not identify any splits that explained differences in quality.

9.2.4.2 Risk Adjusted Analyses

We used ordinary least squares regression to examine linear associations between staffing levels and quality measures, and between staffing deciles and quality measure deciles, after adjusting for the case mix covariates. We also used logistic regression to estimate the likelihood of a facility being in the lowest quality decile and the lowest two quality deciles, if staffing was below the lowest staffing decile or two deciles. We ran these models on individual staff ytpes and while controlling for other staff categories in the model. Third, we used the splits derived from PC-Group to estimate the likelihood that a facility was in the lowest quality or the lowest 5% if staffing was below the PC-Group staffing threshold after adjusting for case mix. Fourth, we developed quality measures indicating whether facilities were in the lowest decile in two or more, three or more, or four or more of the quality measures. Fifth, we used the best logistic regression models and adjusted for facility characteristics that were not highly associated with staffing including occupancy rate, chain, and urban/rural provider. These analyses were conducted separately for each state and each year. We also pooled states within each year and conducted these analyses. The results reported include the staffing levels that are most strongly associated with quality based on our analyses.

9.3 Results

Means and standard deviations for staffing, quality, case mix, and facility measures for 1997 data are provided in Table 9.1. Ranges, interquartile ranges, and medians for these same variables are provided in the Appendix F., Table 2. Nurse staffing levels were highest in the state of Ohio for all types of staff, followed by New York for nurse's aides and RNs, and Texas for LPNs. Overall, LPN time was about twice as high as RN time per resident day, and nurse's aide time per resident day was about double that of RN plus LPN. These mean staffing levels may appear lower than mean staffing levels based on OSCAR data in some states -- especially Texas. However, these figures are supported by a payroll data analysis conducted in Texas in the late 1980s. Reasons for disagreement with average OSCAR staffing levels might include the large number of Medicare-only facilities in Texas (18%) that are excluded from the Medicaid analyses and which have higher staffing levels, inclusion of DONs in OSCAR staffing estimates, and the difference in accuracy between OSCAR and Medicaid staffing estimates. Thus, for the facilities in our sample, we are reasonably confident about the staffing levels used in the analyses.

Means for the quality measures represent the average facility percent of admissions hospitalized with the condition. Total hospitalizations occurring within 30 days of admission averaged 16.7% in New York facilities, 19.1% in Ohio facilities, and 20.6% in Texas facilities. Hospitalization rates for all five of

these conditions represent a significant portion of the total hospitalization rates. Because diagnoses can be listed as the primary or secondary hospital discharge diagnosis, the sum of the percentages for these five diagnoses exceeds the percent hospitalized for all diagnoses. The rates are relatively consistent across states within diagnosis, with electrolyte imbalance the highest, CHF next, then either respiratory infection or UTI, and finally sepsis. These distributions are all skewed, with 25% of facilities with zero or few hospitalizations for the condition, but with maximum rates in some that are five or more times the median value (Appendix F., Table 2). The prevalence of the covariates among admissions to facilities have somewhat greater variability across states, with the most common problems CHF, chronic respiratory disease, and diabetes mellitus.

The majority of the facilities were proprietary, with a lower percentage in the state of New York, and multi-organization chains were particularly prominent in Texas. The percentage of urban facilities varied by state, as did occupancy rates.

Table 9.1 Descriptive statistics for staffing, quality, case mix, and facility measures

Measures	New York (n=502)		Ohio (n=648)		Texas (n=636)		All States (n=1786)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Staffing (in hours per resident day)								
Aide	2.03	(0.35)	2.18	(0.48)	1.77	(0.44)	1.99	(0.47)
LPN	0.61	(0.23)	0.79	(0.31)	0.72	(0.24)	0.71	(0.27)
RN	0.32	(0.20)	0.57	(0.35)	0.18	(0.36)	0.36	(0.36)
RN+LPN	0.92	(0.27)	1.37	(0.51)	0.90	(0.47)	1.08	(0.49)
Quality Measures (% of admissions hospitalized due to each condition)								
CHF	5.93	(3.81)	6.87	(3.62)	6.63	(3.88)	6.52	(3.79)
Electrolyte imbalance	6.22	(4.16)	7.04	(4.17)	7.85	(4.33)	7.10	(4.27)
Respiratory infection	5.14	(3.80)	5.20	(3.59)	5.55	(3.76)	5.31	(3.71)
UTI	4.62	(3.51)	4.75	(3.28)	6.10	(3.86)	5.19	(3.62)
Sepsis	2.16	(2.43)	2.00	(2.02)	2.60	(2.60)	2.26	(2.37)
Covariates (% of admissions with each condition)								
Respiratory problems	22.52	(7.54)	27.70	(8.11)	27.46	(9.30)	26.16	(8.70)
Dysphagia	4.42	(3.88)	8.96	(7.60)	8.81	(7.05)	7.63	(6.85)
Diabetes	23.32	(6.91)	27.03	(7.27)	24.80	(8.91)	25.19	(7.94)
Cancer	10.01	(4.59)	11.41	(5.03)	9.49	(4.73)	10.34	(4.87)
HIV	0.20	(1.78)	0.05	(0.26)	0.14	(1.05)	0.12	(1.14)
Coma	0.96	(1.35)	1.54	(2.02)	2.11	(2.63)	1.58	(2.16)
Quadriplegia, paraplegia	0.88	(1.38)	0.86	(1.67)	0.81	(1.50)	0.85	(1.53)
Urinary retention	4.10	(2.55)	4.30	(2.96)	2.96	(3.00)	3.77	(2.93)
CHF	31.35	(8.15)	36.52	(8.85)	36.71	(9.77)	35.14	(9.31)
Renal failure	7.46	(4.42)	9.92	(5.55)	8.64	(6.06)	8.78	(5.54)
Hypertension	5.38	(3.99)	7.09	(5.31)	6.79	(5.79)	6.50	(5.21)

Facility Characteristics (% of facilities)								
Urban	87.91	---	74.65	---	62.79	---	74.22	---
Chain	12.91	---	55.49	---	83.72	---	53.28	---
Proprietary	52.25	---	76.35	---	72.66	---	75.14	---
Occupancy rate	96.27	(6.19)	83.05	(19.45)	92.52	(26.32)	83.12	(18.36)

The associations between staffing, quality and hospital transfer varied considerably among states, but were consistent within states between 1997 and 1996. Thus, the remainder of the results presented here reflect 1997 data only; results using 1996 data were similar. While statistically significant associations were found using linear regression, the most compelling findings are those in which we identified specific staffing levels below which facilities had an increased likelihood (or odds) of being in the poorest 10% of facilities with respect to hospitalization for the specified condition. Facilities in the highest 10% with respect to hospitalization rates had substantially higher rates than average, as reflected by the skewed distributions.

The relationship between staffing and high hospital transfer rates was strongest and most consistent in the state of New York (Table 9.2). Although we tested multiple staffing thresholds for each type of staff, we report findings at the staffing levels that had the strongest associations with hospital transfer to illustrate the extent of these relationships. Theses were almost always the levels identified by the recursive partitioning approach and so do not fall on a specific decile. All of these associations are adjusted for case mix covariates.

Looking for example at CHF in Table 9.2, if a facility had nurse's aide staffing below 1.21 hours per resident day, the facility was eight times more likely to be in the worst 10% of facilities with respect to hospitalization of people with CHF. However, only 2.4% of facilities in New York had nurse's aide staffing levels below 1.21. For LPNs, staffing below .62 hours per resident day increased the likelihood that a facility will be in the worst 10% of facilities by 3.59 times. In this case, 51% of the facilities do not meet this criterion of .62 hours per resident day, so the threshold is much higher. After trying several thresholds for RN hours per resident day, we did not find an association between RN hours and hospitalization for CHF, but did find an association with RN and LPN hours combined at the level of .76 hours per resident day.

For four of the five quality measures, nurse's aide staffing at about two hours per resident day was associated with about a four-fold increase in the likelihood of high hospitalization rates; 45% of facilities fell below this staffing level. For LPNs, the level varied between .53 and .63, below which there was a substantial increase in hospitalization rates; a staffing level not achieved by between 37% and 53% of facilities. In New York, we found a relationship between RN staffing and hospitalization for sepsis and UTI at a staffing level below .14. However, combined RN and LPN staffing was strongly associated with increased likelihood of hospitalization for all five of the quality measures.

In the state of New York, 24.9% of facilities were in the worst decile for one or more of the quality measures, 12.5% were in the worst decile for two or more quality measures, and 7.4% were in the worst decile for three or more quality measures. We tested whether different staffing thresholds were associated with a facility being in the worst decile, two deciles, or three deciles. In the last portion of Table 9.2, the results are presented for the association between staffing levels and a facility appearing in the lowest decile for three or more of the quality measures. The likelihood of a facility being in this very worst category of hospital transfer was substantially and significantly greater for nurse's aide hours, LPN hours, and sum of LPN and RN hours, with a slightly weaker association with RN hours.

Pooling across states and using the same staffing levels, our findings were relatively consistent with the New York findings, but the likelihood of increased hospitalization was generally less, with a few exceptions (Table 9.3). Nurse's aide thresholds persisted at the level of about two hours per resident day, LPN thresholds at about .5 or .6 hours per resident day, and an RN threshold below .14 hours per resident day was significantly associated with higher odds of hospitalization in four of the five conditions. Overall, about 32.5% of the facilities had one or more quality measures in the worst decile, 14.8% of the facilities had two or more quality measures in the worst decile, and 7.2% of facilities had three or more quality measures in the worst decile. These staffing thresholds were also associated with whether a facility had at least one, at least two, or at least three quality measures in the worst decile.

After adjusting for facility characteristics including occupancy rate, chain ownership, and urban/rural, these increased odds of hospitalization persisted in New York and in all these states combined. Some illustrative logistic regression models estimating the likelihood of being in the worst decile after adjusting for case mix covariates and facility characteristics are provided in Tables 9.4, 9.5, 9.6, and 9.7. For New York 1997 data, the likelihood (or odds) of a facility being in the worst decile for hospitalization due to sepsis was increased by the percentage of patients in the facility with diabetes and HIV, but not cancer -- without facility covariates (Table 9.4). As a facility increased by one decile or 10% of the total facilities in the prevalence of diabetes and HIV, the odds of being in the worst decile for hospitalization from sepsis increased by 1.16 and 1.20 respectively. After adjusting for these covariates, RN hours less than .14 per resident day were associated with an increase of 2.74 times the likelihood of being in the worst decile for hospitalization from sepsis.

For New York in 1997, the likelihood of being in the worst decile for CHF was associated with the respiratory decile, but not significantly associated with whether a provider was urban or rural, or a part of a chain (Table 9.5). Occupancy rates were not included in these models because they were not remotely associated with any of the quality measures. Occupancy rates in each facility's health service area were also tested in the models and, generally, higher occupancy rates were either associated with better quality or no association was found. However, LPN staffing of less than .63 hours per resident day increased the likelihood that a facility would be in the worst decile for CHF hospitalization by 3.5 times.

For the three states combined, both respiratory problems and difficulty swallowing (dysphagia) were associated with increased odds of the worst decile for respiratory infection. After controlling for these case mix characteristics, the sum of RN and LPN hours less than .76 per resident day increased the odds of a hospitalization for respiratory infection in the worst decile (Table 9.6) by 2.4 times. Also for the three states, the likelihood of being in the worst decile for hospitalization from electrolyte imbalance was increased by CHF, renal failure, and hypertension, as well as nurse's aide hours less than 2.06 hours per resident day (Table 9.7).

Table 9.2 Likelihood of hospital transfer for facilities below vs. above the specified staffing level in New York

Quality Measure	Staff Type	Staffing Hours per Resident Day*	Adjusted Odds Ratio (95% CI)†	p- value	% of Facilities Below Staffing Hours‡
CHF	Aide	Below 1.21	8.06 (2.47-26.27)	<.001	2.4
	LPN	Below 0.62	3.59 (1.88 - 6.86)	<.001	51.4
	RN	Below 0.14	0.88 (0.40 - 1.96)	.755	15.1
	RN+LPN	Below 0.76	3.60 (2.01 - 6.45)	<.001	26.5
Electrolyte Imbalance	Aide	Below 2.06	4.46 (2.22 - 8.98)	<.001	46.8
	LPN	Below 0.53	5.51 (2.86-10.62)	<.001	37.1
	RN	Below 0.14	1.66 (0.80 - 3.47)	.176	15.1
	RN+LPN	Below 0.75	5.07 (2.75 - 9.37)	<.001	24.7
Respiratory Infection	Aide	Below 2.05	4.40 (2.14 - 9.04)	<.001	45.4
	LPN	Below 0.55	8.93 (3.98-20.06)	<.001	39.8
	RN	Below 0.14	0.93 (0.39 - 2.19)	.859	15.1
	RN+LPN	Below 0.76	5.08 (2.67 - 9.66)	<.001	26.5
UTI	Aide	Below 2.04	4.77 (2.42 - 9.39)	<.001	44.2
	LPN	Below 0.63	4.09 (1.99 - 8.42)	<.001	53.8
	RN	Below 0.14	2.36 (1.21 - 4.62)	.012	15.1
	RN+LPN	Below 0.54	6.55 (2.81-15.24)	<.001	5.8
Sepsis	Aide	Below 2.06	3.45 (1.78 - 6.68)	<.001	46.8
	LPN	Below 0.63	5.39 (2.45-11.87)	<.001	53.8
	RN	Below 0.14	2.74 (1.37 - 5.44)	.004	15.1
	RN+LPN	Below 0.63	6.06 (3.02-12.13)	<.001	12.0
$ 3 Quality Measures	Aide	Below 2.06	4.21 (1.69-10.47)	.002	46.8
	LPN	Below 0.63	5.93 (1.95-17.99)	.002	53.8
	RN	Below 0.14	2.47 (0.99 - 6.18)	.053	15.1
	RN+LPN	Below 0.76	5.08 (2.29-11.31)	<.001	26.5

* Staffing level representing the treatment variable (“1" denotes below and “0" denotes above) in the logistic regression model estimating the effect on quality.

† Odds that a facility with staffing hours per resident day below the cutoff will be in the worst quality decile relative to facilities with staffing hours per resident day above the cutoff, after adjusting for case mix variables.

‡ The percentage of nursing homes in New York with staffing hours per resident day below the tested cutoff.

Table 9.3 Likelihood of hospital transfer for facilities below vs. above the specified staffing level in New York, Ohio and Texas

Quality Measure	Staff Type	Staffing Hours per Resident Day*	Adjusted Odds Ratio (95% CI)†	p- value	% of Facilities Below Staffing Hours‡
CHF	Aide	Below 1.21	2.30 (1.14 - 4.64)	.020	2.6
	LPN	Below 0.62	1.09 (0.80 - 1.48)	.600	36.8
	RN	Below 0.14	0.98 (0.69 - 1.38)	.888	24.1
	RN+LPN	Below 0.76	1.54 (1.09 - 2.18)	.015	20.2
Electrolyte Imbalance	Aide	Below 2.06	1.64 (1.19 - 2.25)	.002	57.6
	LPN	Below 0.53	1.42 (1.00 - 2.00)	.048	23.4
	RN	Below 0.14	1.46 (1.04 - 2.04)	.027	24.1
	RN+LPN	Below 0.75	1.92 (1.35 - 2.73)	<.001	18.0
Respiratory Infection	Aide	Below 2.05	1.58 (1.16 - 2.15)	.004	55.8
	LPN	Below 0.55	1.79 (1.30 - 2.46)	<.001	26.2
	RN	Below 0.14	1.38 (0.99 - 1.92)	.056	24.1
	RN+LPN	Below 0.76	2.42 (1.74 - 3.36)	<.001	20.2
UTI	Aide	Below 2.04	1.59 (1.17 - 2.15)	.003	55.8
	LPN	Below 0.63	1.44 (1.07 - 1.93)	.016	38.2
	RN	Below 0.14	1.76 (1.28 - 2.43)	<.001	24.1
	RN+LPN	Below 0.54	3.13 (1.72 - 5.69)	<.001	3.7
Sepsis	Aide	Below 2.06	1.78 (1.30 - 2.43)	<.001	57.6
	LPN	Below 0.63	1.68 (1.25 - 2.26)	<.001	38.2
	RN	Below 0.14	1.84 (1.34 - 2.53)	<.001	24.1
	RN+LPN	Below 0.63	2.57 (1.67 - 3.95)	<.001	7.8
$ 3 Quality Measures	Aide	Below 2.06	1.70 (1.14 - 2.54)	.009	57.6
	LPN	Below 0.63	1.94 (1.32 - 2.78)	<.001	38.2
	RN	Below 0.14	1.37 (0.91 - 2.07)	.129	24.1
	RN+LPN	Below 0.76	2.56 (1.71 - 3.84)	<.001	20.2

* Staffing level representing the treatment variable ("1" denotes below and "0" denotes above) in the logistic regression model estimating the effect on quality.

† Odds that a facility with staffing hours per resident day below the cutoff will be in the worst quality decile relative to facilities with staffing hours per resident day above the cutoff, after adjusting for case mix variables.

‡ The percentage of nursing homes in New York with staffing hours per resident day below the tested cutoff.

Table 9.4 Likelihood of being in the worst decile for hospital transfer from sepsis when RN staffing is low (New York)

Variable	Adjusted Odds Ratio	95% CI for Odds Ratio	p-value
Diabetes decile	1.16	(1.04 - 1.29)	.010
Cancer decile	1.01	(0.91 - 1.12)	.848
HIV decile	1.20	(1.06 - 1.35)	.003
RN hours < 0.14 per resident day	2.74	(1.37 - 5.44)	.004

Table 9.5 Likelihood of being in the worst decile for hospital transfer from CHF when LPN staffing is low (New York)

Variable	Adjusted Odds Ratio*	95% CI for Odds Ratio	p-value
Respiratory problems decile	1.14	(1.02 - 1.27)	.017
Diabetes decile	1.04	(0.94 - 1.15)	.469
Urban	2.01	(0.67 - 6.01)	.213
Chain	1.07	(0.45 - 2.55)	.872
LPN hours < 0.63 per resident day	3.50	(1.82 - 6.75)	<.001

* These models were adjusted for case mix as well as facility characteristics, and therefore the odds ratio for the staff variable is not the same as what is displayed in Table 9.2

Table 9.6 Likelihood of being in the worst decile for hospital transfer from respiratory infection when RN+LPN staffing is low (New York, Ohio, and Texas)

Variable	Adjusted Odds Ratio	95% CI for Odds Ratio	p-value
Respiratory problems decile	1.09	(1.04 - 1.15)	.001
Dysphagia decile	1.12	(1.06 - 1.18)	<.001
RN+LPN hours < 0.76 per resident day	2.42	(1.74 - 3.36)	<.001

Table 9.7 Likelihood of being in the worst decile for hospital transfer from electrolyte imbalance when Aide staffing is low (New York, Ohio, and Texas)

Variable	Adjusted Odds Ratio*	95% CI for Odds Ratio	p-value
CHF decile	1.08	(1.02 - 1.14)	.012
Renal failure decile	1.13	(1.06 - 1.20)	<.001
Hypertension decile	1.11	(1.04 - 1.18)	<.001
Urban	1.08	(0.74 - 1.57)	.694
Chain	1.08	(0.78 - 1.49)	.650
Aide hours < 2.06 per resident day	1.57	(1.13 - 2.18)	.008

* These models were adjusted for case mix as well as facility characteristics, and therefore the odds ratio for the staff variable is not the same as what is displayed in Table 9.3

These models illustrate the association between case mix covariates and hospitalization outcomes for specific causes. They also demonstrate that generally facility characteristics had little influence on the rate of hospitalization. However, even after adjustment for case mix characteristics and facility characteristics, facilities below the staffing thresholds reported in Tables 9.2 and 9.3 were at increased risk for being in the worst 10% of facilities from the perspective of hospitalizing residents for avoidable conditions.

9.4 Discussion

These findings demonstrate a clear association between hospital transfer rates for avoidable conditions and staffing levels for nurse's aides, LPNs, and licensed staff (RN and LPN combined). While several staffing thresholds were tested for association with hospital transfers for different types of problems, we did not test all possible thresholds to determine where all associations lie. However, our methodology was designed to test the most likely and most significant staffing thresholds that we could readily identify. Thus, we can answer the fundamental question of this project: for virtually all types of nursing staff, there is some ratio of staff to residents below which residents are at substantial risk of increased quality problems.

As previously discussed in the context of the individual measures, the ability of nursing home staff to influence the selected hospital transfer quality measures is probable. For CHF and electrolyte imbalance, nurse's aides play an essential role in proper attention to fluid intake and dietary issues, as well as early recognition of any changes in a person's breathing or edema. Similarly, LPNs have a major role in medication administration and might be able to detect changes in physical or mental status that are the early warning signs of problems that could lead to hospitalization. RNs play a role not only in oversight of nurse's aides, but also by enhancing the ability of the nursing home to administer IV fluids and thereby avoid hospitalization for dehydration.

Infections, whether respiratory, urinary tract, or sepsis, are the major cause of hospital transfer for nursing home residents. Early recognition of infection in elderly persons can be difficult if they have an underlying dementia or do not experience elevated temperature. Once again, the role of nurse's aides is critical to prevent aspiration pneumonia in individuals with difficulty swallowing through proper positioning and feeding, keeping individuals warm and dry, maintaining appropriate hygiene, and reducing spread of contagious infections through proper precautions. Licensed staff play a crucial role in early identification of infections, enforcing precautions to prevent infections from spreading throughout the facility, and making sure that treatment is initiated so that sepsis - a life-threatening blood-borne infection - does not result. Well-trained and supervised nursing home staff are more likely to identify early symptoms such as confusion, agitation, or non-specific complaints.

The staffing thresholds below which hospitalization rates increased substantially in our study were

relatively high for most types of staff and most quality indicators. While we tested some lower thresholds, the higher staffing thresholds were more strongly associated with quality. Substantial increases in nurse's aide staff and licensed staff may be required to assure that facilities are not putting residents at substantially higher risk for hospitalization. Modest increases in nurse's aide time or licensed time may not be sufficient to achieve these outcomes, although they may result in some improvement.

The associations that were detected between staffing and quality of care were stronger in the New York data set than either of the other states. Such state differences may result from differences in data accuracy, the number and characteristics of facilities certified only by Medicare in the state, diagnosis coding and/or practice patterns. Although Medicaid cost report data are more accurate than OSCAR data, Medicaid data differ from state to state and may differ with respect to accuracy. Because we used Medicaid staffing data, facilities that were certified only Medicare were excluded form these analyses. The number of such facilities differed markedly by state (New York and the fewest) and could influence the staffing associations as well as generalizability of the study to such facilities. Inter-state variation may exist in ICD-9-CM coding for hospital or nursing home encounters used as quality and covariate measures. If physicians in some states are more willing to visit and treat patients in nursing homes, then different hospitalization rates may result. Thus, the precise staffing ratios based on these three states require further validation through analysis of data from other states and facilities that are only certified by Medicare.

These findings strongly support the existence of associations between specific staffing levels and quality of care, as measured by hospital transfer for specific avoidable causes. While there are many dimensions of nursing home quality, hospital transfers of nursing home residents for particular causes are frequently avoidable (Saliba et al., 2000; Ouslander, Weinberg, & Phillips, 2000; Kayser-Jones, 1989). They represent an important marker of quality that nursing home staff can influence.

References

Allman, R. M. (1997). Pressure ulcer prevalence, incidence, risk factors, and impact. Clinical Geriatric Medicine, 13, 421-436.

Barder, L., Slimmer, L., & LeSage, J. (1994). Depression and issues of control among the elderly people in health care settings. Journal of Advanced Nursing, 20, 597-604.

Bowers, B. (1996). The relationship between staffing and quality in long term care facilities. HCFA study on appropriateness of minimum nurse staffing ratios - interim report Baltimore, Maryland: HCFA.

Cohen, J. W. & Spector, W. D. (1996). The effect of Medicaid reimbursement on quality of care in nursing homes. J Health Econ, 15, 23-48.

Creditor, M. C. (1993). Hazards of hospitalization of the elderly. Ann Intern Med, 118, 219-223.

Hall, G. R. (1994). Chronic dementia: challenges in feeding a patient. Journal of Gerontological Nursing, 20, 21-30.

Hartmaier, S. L., Sloane, P. D., Guess, H. A., Koch, G. G., Mitchel, C. M., & Phillips, C. D. (1995). Validation of the minimum data set cognitive performance scale: agreement with the minimental state examination. J Gerontol A Bio Sci Med Sci, 50A, M128-M133.

Hawes, C., Mor, V., Phillips, C., Fries, B. E., Morris, J. N., Steele-Friedlob, E., Greene, A. M., & Nennstiel, M. (1997). The OBRA-87 nursing home regulations and implementation of the resident assessment and care screening (MDS). J Am Geriatr Soc, 45, 977-985.

Health Care Financing Administration (1996). HCFA study on appropriateness of minimum nurse staffing ratios Baltimore, Maryland: HCFA.

Intrator, O., Castle, N. G., & Mor, V. (1999). Facility characteristics associated with hospitalization of nursing home residents: results of a national survey. Med Care, 37, 228-237.

Kayser-Jones, J. & Schell, E. (1997a). The effect of staffing on the quality of care at mealtime. Nursing Outlook, 45, 64-72.

Kayser-Jones, J. (1997b). Inadequate staffing at mealtime: implications for nursing and health policy. Journal of Gerontological Nursing, 23, 14-21.

Kayser-Jones, J., Schell, E. S., Porter, C., Barbaccia, J. C., & Shaw, H. (1999). Factors contributing to dehydration in nursing homes: inadequate staffing and lack of professional supervision. J Am Geriatr Soc, 47, 1187-1194.

Kayser-Jones, J. S., Wiener, C. L., & Barbaccia, J. C. (1989). Factors contributing to the hospitalization of nursing home residents. Gerontologist, 29, 502-510.

Keller, H. H. (1993). Malnutrition in institutionalized elderly: how and why? J Am Geriatr Soc, 41, 1212-1218.

Kramer, A. M., Kowalsky, J. C., Lin, M., & Ecord, M. K. (March 1998). Comparison between the Joint Commission accreditation survey and a concurrent nursing home quality survey. Chapter 9 in Report to Congress on HCFA Survey. Health Care Financing Administration.

Kramer, A. M., Lin, M., Louwe, H., Ecord, M. K., & Kowalsky, J. C. (In preparation). Nursing home case mix and quality demonstration evaluation. Final report volume 3: nursing home survey validity.

Mahoney, F. I. & Barthel, D. W. (1965). Functional evaluation: the Barthel Index. Md State Med J, 14, 61-65.

McKenna, M., Moyers, J., & Feuerberg, M. (1998). Review of non-regulatory quality improvement interventions. Report to Congress on HCFA survey Health Care Financing Administration.

Morley, J. E. & Kraenzle, D. (1994). Causes of weight loss in a community nursing home. JAm Geriatr Soc, 42, 583-585.

Morris, J. N., Fries, B. E., Mehr, D. R., Hawes, C., Phillips, C., Mor, V., & Lipsitz, L. A. (1994). MDS cognitive performance scale. J Gerontol A Bio Sci Med Sci, 49, M174-M182.

Omnibus budget reconciliation act of 1987, Public Law #100-203, Title IV, Subtitle C, Sections 4201-4206 4211-4216, 101 stat 1330-160 to 1330-220, 42 USC Section 1395i-3 (a)-(h) Medicare; 1396r (a)-(h) Medicaid.

Ouslander, J. G. (1997). The resident assessment instrument (RAI): promise and pitfalls. J Am Geriatr Soc, 45, 975-976.

Ouslander, J.G., Weinberg, A.D., & Phillips, V. (2000). Inappropriate hospitalization of nursing facility residents: a symptom of a sick system of care for frail older people. J Am Geriatr Soc, 48, 230-231.

PC-Group (1992). (Version 3.01) [Computer software]. Austin, TX: Austin Data Management Association.

Phillips, C. D., Morris, J. N., Hawes, C., Fries, B. E., Mor, V., Nennstiel, M., & Iannacchione, V. (1997). Association of the Resident Assessment Instrument (RAI) with changes in function, cognition, and psychosocial status [see comments]. J Am Geriatr Soc, 45, 986-993.

Saliba, D., Kington, R., Buchanan, J., Bell, R., Wang, M., Lee, M., Herbst, M., Lee, D., Sur, D., & Rubenstein, L. (2000). Appropriateness of the decision to transfer nursing facility residents to the hospital. J Am Geriatr Soc, 48, 154-163.

Ramsay, J. D., Sainfort, F., & Zimmerman, D. (1995). An empirical test of the structure, process, and outcome quality paradigm using resident-based, nursing facility assessment data. Am J Med Qual, 10, 63-75.

Rice, V. H., Beck, C., & Stevenson, J. S. (1997). Ethical issues relative to autonomy and personal control in independent and cognitively impaired elders. Nursing Outlook, 45, 27-34.

Ryan, C., Bryant, E., Eleazer, P., Rhodes, A., & Guest, K. (1995). Unintentional weight loss in long-term care: predictor of mortality in the elderly. Southern Medical Journal, 88, 721-724.

Smith, D. M. (1995). Pressure ulcers in the nursing home. Ann Intern Med, 123, 433-442.

Spector, W. D. & Takada, H. A. (1991). Characteristics of nursing homes that affect resident outcomes. J Aging Health, 3, 427-454.

Tolley, M. (1997). Power to the patient. Journal of Gerontological Nursing, 23, 7-12.

United States General Accounting Office (1998). California nursing homes: care problems persist despite federal and state oversight. Report to the Special Committee on Aging, U.S. Senate (Rep. No. GAO/HEHS-98-202). Washington, D.C.: United States General Accounting Office.

Wade, D. T. & Collin, C. (1988). The Barthel ADL index: a standard measure of physical disability? Int.Disabil.Studies, 10, 64-67.